FILE COPY FOREST INSECT LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA.

453.2

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project	Date	Author

TITLE

THE RELIABILITY OF CROWN CHARACTERS FOR APPRAISALS OF RISK TO PONDEROSA PINE

By
J. W. Bongberg
Berkeley, California
March 26, 1942

U.S. GOVERNMENT PRINTING OFFICE 8—9742

SUBJECT—

INDEX NO.—

Copies sent to –

Craighead

Kerr

Ewsden

Forest Insect Laboratory
Berkeley, California
March 26, 1942

THE RELIABILITY OF CROWN CHARACTERS FOR APPRAISALS OF RISK TO PONDEROSA PINE

APPROVED BY:

J. M. MILLER
Senior Entomologist, In Charge

SUBMITTED BY:

J. W. BONGBERG
Assistant Entomologist

THE RELIABILITY OF CROWN CHARACTERS FOR APPRAISALS OF RISK TO PONDEROSA PINE

INTRODUCTION

The continued ravages of the tree-killing Dendroctonus beetles in the commercial ponderosa pine forests of northeastern California have prompted the forest entomologist to consider this problem of bark beetle control from all possible angles. The early measures of control in these stands were primarily concerned with methods which could be used to destroy and reduce bark beetle populations. For the most part these direct control measures were effective in reducing subsequent infestations and loss only temporarily and therefore were but partially satisfactory. Recently, an approach which has given considerable promise as an improvement in bark beetle control in these pine stands has been that of sanitation timber salvage, an indirect practice which involves the selective cutting of trees which are highly susceptible to insect attack (3).

Since 1937, the Berkeley Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine, has been engaged in studying the value of light selective sanitation cutting as a means of indirect insect control in commercial pine areas. The first step in this study was to develop a system which would permit an accurate sorting of the yellow pine species (Pinus ponderosa Laws., and P. jeffreyi Greville and Balfour) into groups indicative of their relative risk to subsequent attack by the bark beetles. A method was devised to segregate the trees into four groups of relative risk, by using symptoms and degrees of crown decadence as risk indicators. In contrast to other tree classification systems (1, 2) the appraisals of risk were based only on the needle, twig, and branch characters. The age of the tree and its position in the forest canopy were considered as not having an immediate bearing in indicating current tree health.

In tests of the value which the selective removal of high risk trees would have in reducing subsequent infestations and loss, it was found that satisfactory control could be secured by removing approximately 10 percent of the stand in trees of highest risk. However, when it was found that the cutting of only the highest risk trees did not fully offset the cost of operations in this initial light salvage cut, it became necessary to supplement the volume being cut by selecting additional trees from the group of next lower risk.

In the preliminary tests, the selection of high risk trees for cutting was a matter of judgment on the part of the marker. From comparisons of trees marked for cutting it was found that there was often a considerable difference in opinion among observers on which trees should be marked and cut. In view of the differences in the selection of high risk trees it became apparent that it was necessary to clarify the conception of the relative weight to be given the risk characters and to determine their reliability for use in appraising high risk trees.

There are six crown characters that have thus far been used in appraising the relative risk of individual trees. These six crown characters are: density of crown (primarily the number of needle fascicles per twig), length of needles, color of needles, dead twigs, dead branches, and topkilling. Each of these crown characters was further segregatod into extremes, such as dense or thin, long or short, dark or light, and slight or severe, as the case may be. Thus far in the study on 15 plots comprising a total of 200 acres on the Modoc, Lassen, and Shasta National Forests, a total of 58 trees which had all conditions of crown decadence recorded, have died. By determining the proportional occurrence of each crown character in these trees which died to the occurrence of these characters in the remaining green stand it has been possible to determine the relative reliability of these characters as risk indicators. The information thus obtained should provide a basis for a consistent selection of the trees which should be marked for removal in the light selective cutting practice.

The conclusions drawn thus far in the study are based on an analysis of the crown conditions of the 58 trees that died on the 15 sample plots. The results are tentative and values given each crown character are preliminary. Additional trees in the record of loss are necessary before final appraisals of values can be made.

CROWN CHARACTERS INDICATING HIGH RISK

A comparison was made of the crown conditions of the 58 trees which were attacked and of the remaining trees in the green stand to determine the crown characters which were indicative of trees in a high risk condition. From this comparison it was found that the bark beetles showed an overwhelming preference for trees with thoroughly decadent crowns. Trees with thin top-crowns, as illustrated in figure 1, with short needles, an abundance of dead twigs and branches, and dead tops were selected in greater proportion than was their occurrence in the green stand.

The comparison of the occurrence of crown conditions in the 58 trees that were attacked to the occurrence of these characters in the green stand is given in Table 1. In the table, the ratio of mortality shows the relative liability of trees exhibiting the decadent crown characters to loss, or the ratio of occurrence in the losses to occurrence in the stand. A ratio of mortality above 1.00 indicates a preference by the bark beetles; a ratio below 1.00 indicates a lack of preference.

From Table 1 it will be noted that the bark beetles show a preference for trees with thin crowns six times greater than is the occurrence of that character in the green stand. Similarly, trees with short needles, an abundance of dead twigs and branches, and top-killing injuries, are prefered more often than they occur in the stand as a whole. Although the comparison of the crown conditions in the trees which were attacked to the remaining trees in the green stand showed that trees exhibiting decadent crown symptoms were prefered by the bark beetles, this comparison failed to reveal the significance or reliability of each crown character, <u>independent</u> of other crown conditions.

Table 1. Crown Characters Associated with Risk of Ponderosa Pine

Crown Factor	Green Stand		Trees Killed		Ratio of Mortality
	No. of Trees	Percent Total	No. of Trees	Percent Total	
Top Crown Density					
Dense	842	86.02	9	15.52	0.18
Thin	137	13.98	49	84.48	6.04
Top Needle Length					
Long	842	86.02	19	32.76	0.38
Short	137	13.98	39	67.24	4.81
Needle Color					
Dark	589	60.22	5	8.62	0.14
Light	390	39.78	53	91.38	2.98
Twig Injury					
Light	769	78.49	7	12.07	0.15
Severe	210	25.51	51	87.94	4.09
Branch Injury					
Light	831	84.95	16	27.59	0.33
Severe	148	15.05	42	72.41	4.81
Top-Killing					
Absent	895	91.42	36	62.07	0.68
Present	84	8.58	22	37.93	4.41

RELIABILITY OF RISK INDICATORS

Thin Crowns

The loss of trees with a thin complement of needles was over six times as great as was the occurrence of these thin-crowned trees in the green stand. The high ratio of mortality indicates that a thin top-crown resulting from a sparse complement of needles is first in value as a character to be used in indicating high risk. Experience has shown that many trees which are attacked by bark beetles exhibit a progressive weakness in the top-crowns. This condition is readily discernible because of the contrast in density between the top and lower portions of the crown in the same tree. The high ratio of mortality of trees with thin crowns bears out the conception that any tree which tends to show a decided contrast in the density of foliage between the top and lower portion of the crown is a high risk type and quite likely to be selected by the bark beetles in their attacks.

Short Needles

Should a short needle condition also prove to be a valuable and reliable character as a risk indicator, trees with thin crowns and short needles should increase the ratio of mortality over that of trees only with thin crowns. Actually but 35 of the 49 trees with thin crowns had short needles. The relative liability to attack, or ratio of mortality, of these 35 trees was 5.61. This ratio of mortality which is below that obtained for thin crowns alone indicates that short needles are not outstanding as a reliable character indicating high risk. Independent of thin crowns, but two of the 58 trees which were attacked had short needles. The ratio of mortality of these two trees was 1.07. From this low rate of loss it would appear that trees with short needles alone are not particularly preferred by the bark beetles.

It is possible that the length of needles may be inherent in some trees. Also, the length to which needles may grow is quite likely to be influenced by the physiological functions of the tree processes. A lack of sufficient moisture and nutrients necessary for proper tree growth would result in decreased tree vigor and would be evidenced in the length of needles. However, from the evidence shown in the loss data, short needles are dependent on the top-crown density and are not a reliable factor, per se, as a character of value in indicating poor tree health.

Needle Color

The intensity of green color in the needles of living ponderosa pines may remain fairly constant, but an appraisal of that color often differs under varying intensities and conditions of light. Occasionally a living tree will be observed with needles definitely an off-green. However, thus far in the loss record this factor has not been observed except in association with thin crowns. For that reason no appraisal can be made of the reliability of poor colored needles as an indicator of high risk.

Dead Twigs and Branches

Dead and dying twigs and branches in the crowns of ponderosa pines may indicate some unbalanced condition in the physiology of the tree or the result of attacks on the twigs and branches by insects or fungi. Any extended and severe invasion of insect enemies to the twigs and branches would obviously result in the death of the tree. In many cases trees have been observed in which localized injuries have occurred in the upper portions of the crown. These injuries undoubtedly influence the health of such trees and should be considered in appraisals of risk. However, in the record of loss, trees with an abundance of dead twigs and branches, independent of the other above mentioned deteriorated crown characters, occurred in but two of the 58 trees which were attacked. The ratio of occurrence of trees with severe twig and branch injuries in the loss to the occurrence of these characters in the green stand was 0.80. This low ratio of mortality indicates a lack of preference by the bark beetles for trees with severe branch injuries alone and that dead twigs and branches are not reliable and are of but little use for appraising current high risk.

Top-killing

Top-killing, a condition in which only a portion of the crown, usually less than 25 percent of the top, becomes infested and dies, is frequently encountered in the mature and overmature stands of ponderosa pine. This top-killing is often the result of insects mining the cambium in the top portion of the tree. In other cases, these top injuries may be the result of a continuing deterioration of a thin top-crown. Active or recent top-killing is sufficient to warrant an appraisal that the tree is in poor health and of decided high risk. In many top-killed trees, an active insect infestation may subside for a period but become evident again in a progressive weakening below the previous top injury. Experience has shown that such trees are decidedly of a high risk type regardless of whether or not the complement of needles is sparse below the top injury. Sufficient data are not available which would permit an independent appraisal of the relative significance of top-killing as a character for appraising high risk. However, the progressive weakness which often develops below a pervious top-kill warrants the conclusion that top-killing is of definite value as an indication of high risk.

WEIGHT OF CHARACTERS USED AS RISK INDICATORS

Sufficient data are not available to justify fully the conclusions which have been made of the reliability and significance of all crown characters used as risk indicators. For that reason it is not possible to determine adequately the relative weight which should be given each crown character. With sufficient trees in the record of loss it would be possible to weight each of the crown characters which showed reliability as indicators. The following comparison may be made, however, in regard to the characters of thin crown, short needles, and dead branches. The lowest ratio of mortality for independent characters was obtained for that of dead branches. By using the ratio of mortality of 0.80 for branch killing as a unit of comparison to short needles and thin crowns, the relative weight which should be given short needles is 1.90 and that for thin crowns 7.55.

SUMMARY AND CONCLUSIONS

The decadence of the crowns of individual trees in the ponderosa pine stands of northeastern California has been used for judging the relative susceptibility or risk of trees to attack by bark beetles. As an indirect insect control measure, trees with deteriorated crowns are regarded as high risk and selected for removal from the stand through light selective logging practice. This study was undertaken to determine the reliability of deteriorated crown characters as indicators of high risk in order that standard appraisals of high risk and consistent selections could be made of trees to be cut in the sanitation-salvage treatment.

The reliability of certain crown characters as indicators of high risk has been determined by a study of 58 dead trees. A ratio of mortality was obtained for each of six decadent crown factors which occurred in the 58 trees that were attacked. The following conclusions are drawn from the study.

1. A sparse complement of needles in the top-crown, in contrast to a more dense foliage below, is most reliable and first in value as a character to be used in indicating high risk.

2. Short needles which were encountered in some of the trees, occurred primarily as a character dependent on the thin top-crowns. Short needles alone were judged to be unreliable and of little value as an indicator of high risk.

3. Needles of an off-green color were not encountered in the trees which were killed without the association of a thin crown density Poor colored needles, therefore, appear to be dependent on thin crowns. No appraisal could be made from the data available of the value of off-colored needles as an indicator of high risk.

4. The occurrence of numerous dead twigs and branches in the trees which were killed was no more numerous than was its occurrence in the green stand. Dead twigs and branches, when localized and concentrated in the upper portions of the crown indicate a weakened condition in the tree and should be considered as evidence of poor tree health. From the analysis of data, however, it was indicated that severe branch and twig injuries are of limited value as indicators of current high risk.

5. Trees which had been top-killed occurred in greater proportions in the trees that were attacked than in the remaining trees in the green stand. No appraisal could be made from the data available of the weight or significance of top-killing as a character indicating high risk. It had been observed, however, that a progressive weakness often develops below a previous top injury and it is concluded, therefore, that a top injury is of definite value as a character to be used in appraising high risk.

REFERENCES

1. Dunning, Duncan. 1928. "A tree classification for the selection forests of the Sierra Nevada." Jour. Agr. Res. 36(9):755-771. illus.

2. Keen, F. P. 1936. "Relative susceptibility of ponderosa pines to barkbeetle attack." Jour. Forestry 34(10):919-927. illus.

3. Salman, K. A., and Bongberg, J. W. 1942. "Removing high risk trees for control of insects in pine stands of northeastern California." Jour. Forestry (in press).

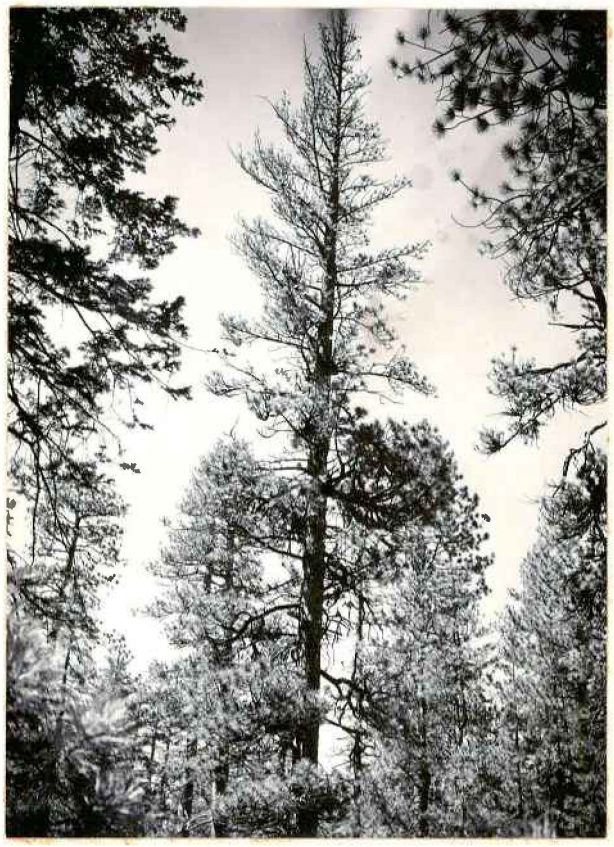

Fig. 1. A thin crowned ponderosa pine, a type of tree frequently selected for attack by bark beetles. (Photo by M. D. Wygant)